

Phytogetic ingredients in the spotlight:

## Fenugreek - a versatile medicinal herb

You've never heard of fenugreek? Don't worry, compared to other herbs like thyme, rosemary or basil, fenugreek is relatively unknown in Europe. **Herewith we want to show the benefits of fenugreek for humans and animals.**

Looking back on the long history of fenugreek, it has been used for several reasons.

**Fenugreek was used in ancient Egypt, where it played a role in both herbal medicine and religious acts<sup>1</sup>.** In Greece, fenugreek is still used as animal feed. This is where the Latin name of fenugreek *Trigonella Foenum-Graecum* comes from, which means „Greek hay“<sup>2</sup>.



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**Fenugreek is one of the oldest cultivated and medicinal plants in the world.** Thousands of years ago, the herbaceous plant was already highly regarded in the cultures of Egypt, China, India, the Arab countries, the Roman Empire and Greece. Fenugreek was probably even one of the first plants ever cultivated by man: the oldest seed findings date back to the 6<sup>th</sup> millennium B.C. near the Euphrates and Tigris rivers. **A clay tablet from the 8<sup>th</sup> century B.C.** documents fenugreek as a plant of the royal medicinal plant garden of the Babylonian King Marduk-apla-iddina II<sup>1</sup>.

The first written mention of fenugreek, however, dates back some 900 years earlier: **scrolls from ancient Egypt recommended the use of fenugreek for the treatment of burns.** The Greek physician Hippocrates (ca. 460-370 B.C.) also recommended the use of the plant - but for tumours<sup>3</sup>. Fenugreek finally made its way north of the Alps through Benedictine monks, who cultivated it in their monastery gardens<sup>1</sup>. In addition, Charlemagne's Capitulare de villis, which was issued in 795, decreed that fenugreek be cultivated in the king's gardens, monastery gardens and crown estates<sup>1,3,4</sup>.

**Nowadays the use of fenugreek is widespread, especially in India. It is an indispensable ingredient of curry.** Usually, fenugreek has no harmful effects on health, though sometimes it can cause allergic reactions in people who are sensitive to peanuts<sup>5</sup>.

Fenugreek is mainly used as leaves (fresh or dried), as seeds (whole or ground) or as extract. The form depends on the type of use, from spices, vegetables, tea, through cosmetic products to animal feed - the range of applications is wide. **Did you know that fenugreek is mainly used in nursing teas because it stimulates the production of milk<sup>6</sup>? In addition, some people also take fenugreek capsules as a dietary supplement because of their high content of vitamins and minerals.**

## Fenugreek in Portrait

Fenugreek (*Trigonella foenum-graecum* L.) belongs to the Fabacea family, also known as butterfly blossom plants or legumes. Like over 70 other species, fenugreek belongs to the genus *Trigonella*. The annual **herbaceous plant with light green leaves and small flowers** grows to about 60 cm high and forms a deep reaching tap root.

Fenugreek can be found in dry biotopes of the eastern Mediterranean region and West Asian countries. The plant prefers nutrient-rich, warm and sunny locations and is therefore **cultivated today mainly in India, Turkey, Morocco and France**<sup>4</sup>. Until a few years ago, fenugreek was also cultivated in Lower Austria for the feed and pharmaceutical industries. However, in modern agriculture the plant is considered to have too low yields. In arid regions, however, it is worthwhile cultivating the plant: where heavy irrigation has led to soil salinization, optimal conditions are available for salt-tolerant fenugreek<sup>7</sup>.

From June to July fenugreek blooms with pale yellow flowers. The flowers, which are fertilized by bees, bumblebees or butterflies, develop into legumes up to 15 cm long and 1 cm wide. The pods contain up to 20 yellowish reddish-brown rhomboid seeds of about 3-5 mm long and 1-2 mm thick, which are divided into two unequal halves by a diagonal furrow<sup>7</sup>.

**Fenugreek is characterised by its peculiar, sweetishly spicy smell.** This coumarin-like smell even intensifies with drying. When the seeds germinate, the smell is more reminiscent of celery - the seedlings also taste bitter and are slimy when chewed.



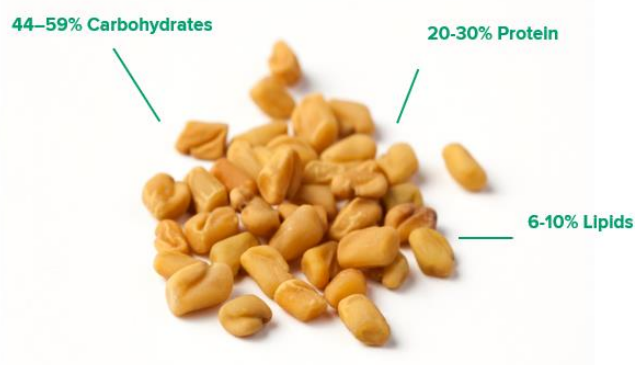
The flowers of fenugreek are fertilized by bees, bumblebees or butterflies. ©GettyImages

## Active ingredients in fenugreek

Fenugreek seeds have a high content of various minerals: **calcium, zinc, phosphorus, manganese and iron** are present in high concentrations compared to other legumes. The seeds are also rich in saponins, flavonoids, carotenoids and coumarins<sup>8,9</sup>.

The dried fenugreek seeds contain<sup>3,9</sup>

- protein (rich in arginine, alanine and glycine, but poor in lysine and methionine): 20-30%,
- lipids (mainly as unsaturated fatty acids): 6-10%,
- carbohydrates (mainly as galactomannans): 44-59%



Content of dried fenugreek seeds according to Basu and Srichamroen (2010) ©GettyImages

According to Basu and Srichamroen (2010), fenugreek seeds contain three active components which are responsible for its health-promoting effect: **galactomannans, saponins and 4-hydroxy-isoleucine**. Here we would like to introduce you to these main components in fenugreek<sup>9</sup>:

**Galactomannans:** Galactomannans are polysaccharides which consist of galactose and mannose. These polysaccharides are abundant in the cell walls of the endosperm of legume seeds. Galactomannans differ in their ratio of galactose to mannose. These **structural properties of the galactomannans from fenugreek seeds enable an increase in the viscosity of the ingesta in the intestine**<sup>9</sup>.

**Saponins:** Saponins are particularly abundant in legumes - but are also found in numerous other plants, e.g. in the so-called soap tree *Quillaja saponaria*. **Saponins can be very different in their structure, but they have one thing in common: they have a sugar residue which is linked to a triterpenoid or steroid part.** In fenugreek, the sugar residue is connected to the steroid part. The saponins in fenugreek therefore belong to the steroidal saponins<sup>9</sup>.

**4-hydroxy-Isoleucine (4-OH-Ile):** 4-hydroxy-isoleucine is a polar non-protein amino acid that **occurs exclusively in some selected plants, especially in Trigonella species.** In fenugreek seeds the amino acid is present as a diastereoisomer<sup>9</sup>.

Table 1: Effects of the active compounds of fenugreek seeds (according to Krämer, 2013)

Effect	Reference
<b>Saponins</b>	<ul style="list-style-type: none"> <li>• Hypocholesterolemic</li> <li>• Inhibition of inflammatory cytokine production in THP-1 cells and melanogenesis in B16F1 cells</li> <li>• Antifungal</li> <li>• Improvement of adipocyte differentiation and inhibition of inflammation in fatty tissue</li> <li>• Hemolytic</li> </ul>
<b>Galactomannans</b>	<ul style="list-style-type: none"> <li>• Increase of intestinal digestive enzymes in rats with diabetes</li> <li>• Increase of the phagocytosis rate of peritoneal macrophages</li> <li>• Hypoglycemic</li> </ul>
<b>4-Hydroxy-Isoleucin</b>	<ul style="list-style-type: none"> <li>• Stimulation of insulin secretion</li> </ul>

## The amazing modes of action of fenugreek

As early as the 11<sup>th</sup> century, Hildegard von Bingen recommended fenugreek to all those who reject food, as well as for fever and against skin diseases<sup>17</sup>.

In addition, until a few decades ago fenugreek seeds were used in so-called livestock powders - a generally strengthening and appetite-stimulating combination of plants and salts. **To this day, fenugreek seeds are used in folk medicine in a wide variety of areas<sup>18</sup>:**

Here are just some examples:

- in the treatment of dandruff
- to reduce loss of appetite
- to treat inflammation of the upper respiratory tract
- fenugreek seeds can be found in breast-feeding teas to promote milk production
- or as a supportive treatment for diabetes.

In general, it can be said that fenugreek is an ancient cultivated plant which has many influences on the organism of humans and animals:

## Influence on the blood glucose level

Fenugreek and its active ingredients are becoming increasingly important in human diabetes research due to their **blood sugar lowering effect**:

A study observed an increase in glucose-induced insulin release in human pancreatic cells and in pancreatic cells of rats. According to Basch et al. (2003), the reason for these effects is the amino acid 4-hydroxy-isoleucine, which has only been found in fenugreek so far. The authors also found an increase in insulin receptors and a **decrease in plasma glucose concentration**. However, the exact mechanism of action is still unclear<sup>18</sup>.

There are further explanations for the blood glucose lowering effect of the galactomannans of fenugreek: According to Basu and Srichamroen (2010), the **galactomannans increase the viscosity of the digesta in the intestine**. By that, the **chyme remains in the intestine for a longer period**. A longer residence time results in a delayed carbohydrate breakdown. Thus, the glucose accumulation in the blood after food intake is delayed<sup>9</sup>.

## Influence on the gastric mucosa and on the activity of digestive enzymes

Suja Pandian et al. (2002) showed that fenugreek seeds have a **protective effect on the stomach lining**: They induced lesions to the stomach mucosa of rats using ethanol and fed the rats aqueous fenugreek extract or a fenugreek seed fraction. This feeding **reduced the formation of gastric ulcers** by over 50 %. The severity of the lesions was also lower in the group fed with fenugreek seed than in the control group.

The authors even went one step further: compared to the administration of omeprazole, an effective drug for the inhibition of H<sub>2</sub>, the aqueous fenugreek extract was equally effective. The gel fraction of the seeds was even more effective with regard to gastric ulcers<sup>19</sup>.

The seeds of fenugreek seem to have a protective role on the stomach lining due to their **antisecretory activity**. Suja Pandian et al. (2002) suspect that the composition of the polysaccharides and the flavonoids are responsible for the gastroprotective effect.

*In vitro* and *in vivo* studies in rats showed that fenugreek in some cases **significantly increased the activity of digestive enzymes such as maltase, lactase and saccharase as well as intestinal lipase** with a single administration of 40 mg. Again, the administration of 2 g fenugreek/kg dry matter of the feed led to an **increased activity of the digestive enzymes**<sup>9,20,21,22</sup>.

The activities of pancreatic lipase and chymotrypsin were each increased by 42 %. *In vitro*, the use of fenugreek in concentrations of 0.1 mg/ml and 1.0 mg/ml respectively led to an increase in the activity of various digestive enzymes<sup>9,20,21,22</sup>.

## Anti-oxidative effects of fenugreek

Fenugreek has **anti-oxidative properties**<sup>23,24,27</sup>. This means that this plant can help to prevent and **reduce damage resulting from oxidative processes** (oxidative stress) in human and animal bodies.

Although oxidative processes are necessary for ordinary function of our metabolism, they need to be balanced. So called oxidative stress is detrimental.

Oxidative stress occurs, if there is an imbalance between the occurrence of oxidants (also called reactive oxygen species) and the ability of the bodies' antioxidant defense system to detoxify these oxidants or repair damage caused by them.

It is associated with some diseases (cancer, disorders of the immune system or rheumatic diseases) and premature ageing, as it affects the repair and detoxification function of cells.



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## Did you know?

The **anti-inflammatory effects** of purified fenugreek seed extract in various concentrations (5-40 mg/kg body mass) were tested in mice and compared to the analgesics diclofenac and pentazocin.

In their study, Vyas et al. (2008) found that at a dose of 40 mg/kg fenugreek seed extract, decreased the pain response by 75%, after chemical or thermal provocation. In contrast, the administration of diclofenac reduced the pain expressions by 63%. In addition, an acute inflammatory reaction was observed, which was accompanied by the production of prostaglandin E2 and prostaglandin 2 $\alpha$ <sup>25</sup>.

The authors therefore assumed that treatment with fenugreek seed extract suppresses the formation of these substances or leads to an antagonistic effect. Furthermore, the authors suspected that fenugreek seed extract has a centrally mediated **pain-relieving effect**<sup>25</sup>

In a further study, the influence of fenugreek seed on the immune system of mice was tested. Three different concentrations (50 - 250 mg/kg body mass) of a fenugreek seed extract were fed. The authors observed an increase in the humoral immune response, an increased cell-mediated immune response and an increased phagocytic capacity. Including previous studies, it was assumed that the components responsible for the increased immune response are probably saponins, flavonoids and fibre components<sup>26</sup>.

## Short Facts – Fenugreek

- **The liver benefits from the dietary intake of fenugreek seeds because they have a positive effect on bile formation and bile flow** and - presumably by regulating cholesterol metabolism - effectively prevent the formation of gallstones (cholesterol stones)<sup>27</sup>.
- **Fenugreek seeds have a gastroprotective effect.** The mucus fraction of fenugreek seeds has been found to be superior to omeprazole (proton pump blocker) in the prevention of gastric mucosal ulcerations. In rats, aqueous extracts promoted the healing of stomach ulcers<sup>27</sup>.
- **Fenugreek seeds are considered worldwide to be the most important herbal galactagogue for humans and animals**<sup>28</sup>. They promote the growth of the mammary gland and significantly increase the amount of milk. This could be proven for humans, but also for goats, cows, buffalos and other animals. It has been shown that human infants lose significantly less weight after birth and regain their birth weight more quickly when their mothers drink fenugreek tea

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